

What is claimed is:

1 1. An apparatus for automatically modifying circuit
2 design information (hereinafter called the HDL
3 description) described in a hardware description language
4 (HDL), said apparatus comprising:

5 (a) HDL lexical analysis means for performing a
6 lexical analysis of the HDL description which is to be
7 modified;

8 (b) HDL syntax analysis means for performing a syntax
9 analysis of the HDL description based on the result of
10 the lexical analysis by said HDL lexical analysis means,
11 to convert the HDL description into a parse tree format
12 description;

13 (c) semantic grammar error detection means for
14 performing semantic analysis of the HDL description based
15 on the result of the syntax analysis by said HDL syntax
16 analysis means, detecting a portion of the HDL description,
17 in which portion variables on right and left sides of an
18 assignment statement are inconsistent in type, and
19 regarding the detected portion as a semantic-grammar-error
20 portion;

21 (d) a type conversion template for defining a type
22 conversion function, which converts the type of the
23 variable on the right side of the assignment statement
24 into that of the variable on the left side of the assignment

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25 statement, as a type conversion rule;

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(e) semantic grammar error modifying means for modifying said semantic-grammar-error portion into a correct description by applying said type conversion function, which has been defined by said type conversion template, to the right side of the assignment statement which side has been regarded as said semantic-grammar-error portion by said semantic grammar error detecting means;

(f) HDL reverse syntax analysis means for performing a reverse syntax analysis of the HDL description, which has been modified by said semantic grammar error modifying means, to convert the HDL description from said parse tree format description into an ordinary format description; and

40 (g) comment attaching means for attaching a comment
41 about the modification to the modified portion, which is
42 the portion as the result of the modification by said
43 semantic grammar error modifying means.

1 2. An apparatus according to claim 1, further
2 comprising:

3 (h) a control information template for defining a
4 to-be-modified item (hereinafter called "object item"),
5 which is not a grammar error but should be considered in
6 view of circuit designing, and a modification rule to modify
7 said object item;

8 (i) object item detecting means for detecting a
9 portion corresponding to said object item in the HDL
10 description, based on the result of the syntax analysis
11 by said HDL syntax analysis means; and

12 (j) object item modifying means for modifying the
13 last-named corresponding portion, which has been detected
14 by said object item detecting means, in accordance with
15 said modification rule defined by said control information
16 template;

17 said HDL reverse syntax analysis means being operable
18 to perform a reverse syntax analysis of the modified HDL
19 description, which is the description as the result of
20 the modification by said semantic grammar error modifying
21 means and said object item modifying means;

22 said comment attaching means being operable to attach
23 a comment about the modification to the modified
24 corresponding portion, which is the portion as the result
25 of the modification by said semantic grammar error
26 modifying means and said object item modifying means.

1 3. An apparatus for automatically modifying circuit
2 design information (hereinafter called the HDL
3 description) described in a hardware description language
4 (HDL), said apparatus comprising:

5 (a) HDL lexical analysis means for performing a
6 lexical analysis of the HDL description which is to be
7 modified;

8 (b) HDL syntax analysis means for performing a syntax
9 analysis of the HDL description based on the result of
10 the lexical analysis by said HDL lexical analysis means,
11 to convert the HDL description into a parse tree format
12 description;

13 (c) a control information template for defining a
14 to-be-modified item (hereinafter called "object item"),
15 which is not a grammar error but should be considered in
16 view of circuit designing, and a modification rule to modify
17 said object item;

18 (d) object item detecting means for detecting a
19 portion corresponding to said object item in the HDL
20 description, based on the result of the syntax analysis
21 by said HDL syntax analysis means;

22 (e) object item modifying means for modifying the
23 last-named corresponding portion, which has been detected
24 by said object item detecting means, in accordance with
25 said modification rule defined by said control information
26 template;

27 (f) HDL reverse syntax analysis means for performing
28 reverse syntax analysis of the modified HDL description,
29 which is the description as the result of the modification
30 by said object item modifying means, to convert the HDL
31 description from said parse tree format description into
32 an ordinary description; and

33 (g) comment attaching means for attaching a comment
34 about the modification to the modified corresponding

35 portion, which is the portion as the result of the
36 modification by said object item modifying means.

1 4. An apparatus according to claim 2, wherein said
2 control information template defines:

3 said object item in such a manner that, on the
4 assumption that the HDL being currently modified is
5 converted into another HDL, said object item detecting
6 means detects a portion of the current HDL description,
7 which portion does not comply with language rules of the
8 second-named HDL, as a portion corresponding to said object
9 item; and

10 said modification rule in such a manner that said
11 object item modifying means modifies the last-named
12 corresponding portion, which has been detected by said
13 object item detecting means, into a description that
14 complies with the language rules of said second-named HDL.

1 5. An apparatus according to claim 3, wherein said
2 control information template defines:

3 said object item in such a manner that, on the
4 assumption that the HDL being currently modified is
5 converted into another HDL, said object item detecting
6 means detects a portion of the current HDL description,
7 which portion does not comply with language rules of the
8 second-named HDL, as a portion corresponding to said object
9 item; and

10 said modification rule in such a manner that said
11 object item modifying means modifies the last-named
12 corresponding portion, which has been detected by said
13 object item detecting means, into a description that
14 complies with the language rules of said second-named HDL.

1 6. An apparatus according to claim 4, wherein if
2 the current HDL is case-sensitive, in consideration of
3 a possibility that the current HDL might be converted into
4 another HDL that is case-insensitive, said control
5 information template defines:

6 said object item in such a manner that said object
7 item detecting means detects one of a pair of character
8 strings which are composed of common characters arranged
9 in the same order and described case-sensitively, as a
10 portion corresponding to said object item; and

11 said modification rule in such a manner that said
12 object item modifying means modifies the last-named
13 corresponding portion, which has been detected by said
14 object item detecting means, by generating a new character
15 string that is not contained in the HDL description, and
16 then replacing said one of the two character strings, which
17 has been detected by said object item detecting means,
18 with said new character string.

1 7. An apparatus according to claim 5, wherein if
2 the current HDL is case-sensitive, in consideration of

3 a possibility that the current HDL might be converted into
4 another HDL that is case-insensitive, said control
5 information template defines:

6 said object item in such a manner that said object
7 item detecting means detects one of a pair of character
8 strings which are composed of common characters arranged
9 in the same order and described case-sensitively, as a
10 portion corresponding to said object item; and

11 said modification rule in such a manner that said
12 object item modifying means modifies the last-named
13 corresponding portion, which has been detected by said
14 object item detecting means, by generating a new character
15 string that is not contained in the HDL description, and
16 then replacing said one of the two character strings, which
17 has been detected by said object item detecting means,
18 with said new character string.

1 8. An apparatus according to claim 4, wherein if
2 the current HDL is case-insensitive, in consideration of
3 a possibility that the current HDL might be converted into
4 another HDL that is case-sensitive, said control
5 information template defines:

6 said object item in such a manner that said object
7 item detecting means detects every upper case character
8 or every lower case character in a character string, as
9 a portion corresponding to said object item; and

10 said modification rule in such a manner that said

11 object item modifying means modifies the last-named
12 corresponding portion, which has been detected by said
13 object item detecting means, by converting every upper
14 case character into a lower case character, or every lower
15 case character into an upper case character.

1 9. An apparatus according to claim 5, wherein if
2 the current HDL is case-insensitive, in consideration of
3 a possibility that the current HDL might be converted into
4 another HDL that is case-sensitive, said control
5 information template defines:

6 said object item in such a manner that said object
7 item detecting means detects every upper case character
8 or every lower case character in a character string, as
9 a portion corresponding to said object item; and

10 said modification rule in such a manner that said
11 object item modifying means modifies the last-named
12 corresponding portion, which has been detected by said
13 object item detecting means, by converting every upper
14 case character into a lower case character, or every lower
15 case character into an upper case character.

1 10. An apparatus according to claim 2, wherein said
2 control information template defines:

3 said object item in such a manner that said object
4 item detecting means detects a character string which
5 includes a predetermined prohibited character, as a

6 portion corresponding to said object item; and
7 said modification rule in such a manner that said
8 object item modifying means modifies the last-named
9 corresponding portion, which has been detected by said
10 object item detecting means, by generating a new character
11 string which neither is contained in the HDL description
12 nor includes said predetermined prohibited character, and
13 then replacing the prohibited-character-included
14 character string, which has been detected by said object
15 item detecting means, with said new character string.

1 11. An apparatus according to claim 3, wherein said
2 control information template defines:
3 said object item in such a manner that said object
4 item detecting means detects a character string which
5 includes a predetermined prohibited character, as a
6 portion corresponding to said object item; and
7 said modification rule in such a manner that said
8 object item modifying means modifies the last-named
9 corresponding portion, which has been detected by said
10 object item detecting means, by generating a new character
11 string which neither is contained in the HDL description
12 nor includes said predetermined prohibited character, and
13 then replacing the prohibited-character-included
14 character string, which has been detected by said object
15 item detecting means, with said new character string.

1 12. An apparatus according to claim 2, wherein said
 2 control information template defines:

3 said object item in such a manner that said object
 4 item detecting means detects a portion of the HDL
 5 description, which portion is inconsistent in terminal
 6 description between a plurality of hierarchical levels
 7 of the HDL description, as a portion corresponding to said
 8 object item; and

9 said modification rule in such a manner that said
 10 object item modifying means modifies the inconsistent
 11 terminal description in the last-named corresponding
 12 portion, which has been detected by said object item
 13 detecting means, into a correct description which is
 14 consistent between all of the plural hierarchical levels
 15 of the HDL description.

1 13. An apparatus according to claim 3, wherein said
 2 control information template defines:

3 said object item in such a manner that said object
 4 item detecting means detects a portion of the HDL
 5 description, which portion is inconsistent in terminal
 6 description between a plurality of hierarchical levels
 7 of the HDL description, as a portion corresponding to said
 8 object item; and

9 said modification rule in such a manner that said
 10 object item modifying means modifies the inconsistent
 11 terminal description in the last-named corresponding

12 portion, which has been detected by said object item
13 detecting means, into a correct description which is
14 consistent between all of the plural hierarchical levels
15 of the HDL description.

1 14. An apparatus according to claim 2, wherein said
2 control information template defines:

3 said object item in such a manner that said object
4 item detecting means detects a portion of the HDL
5 description, which portion yields an incorrect
6 relationship between the left and the right sides of a
7 signal assignment description, as a portion corresponding
8 to said object item; and

9 said modification rule in such a manner that said
10 object item modifying means modifies the last-named
11 corresponding portion, which has been detected by said
12 object item detecting means, into a correct description
13 which yields a correct relationship between the left and
14 the right sides of said signal assignment description.

1 15. An apparatus according to claim 3, wherein said
2 control information template defines:

3 said object item in such a manner that said object
4 item detecting means detects a portion of the HDL
5 description, which portion yields an incorrect
6 relationship between the left and the right sides of a
7 signal assignment description, as a portion corresponding

8 to said object item; and
9 said modification rule in such a manner that said
10 object item modifying means modifies the last-named
11 corresponding portion, which has been detected by said
12 object item detecting means, into a correct description
13 which yields a correct relationship between the left and
14 the right sides of said signal assignment description.

1 16. An apparatus according to claim 2, wherein said
2 control information template defines:

3 said object item in such a manner that said object
4 item detecting means detects a portion of the HDL
5 description, which portion is unable to be synthesized
6 by a logic synthesis tool, as a portion corresponding to
7 said object item; and

8 said modification rule in such a manner that said
9 object item modifying means deletes the last-named
10 corresponding portion, which has been detected by said
11 object item detecting means.

1 17. An apparatus according to claim 3, wherein said
2 control information template defines:

3 said object item in such a manner that said object
4 item detecting means detects a portion of the HDL
5 description, which portion is unable to be synthesized
6 by a logic synthesis tool, as a portion corresponding to
7 said object item; and

8 said modification rule in such a manner that said
9 object item modifying means deletes the last-named
10 corresponding portion, which has been detected by said
11 object item detecting means.

1 18. An apparatus according to claim 2, wherein said
2 control information template defines:

3 said object item in such a manner that said object
4 item detecting means detects a portion of the HDL
5 description, which portion is unable to be synthesized
6 by a logic synthesis tool, as a portion corresponding to
7 said object item; and

8 said modification rule in such a manner that said
9 object item modifying means adds to the last-named
10 corresponding portion, which has been detected by said
11 object item detecting means, a directive for instructing
12 said logic synthesis tool to ignore said last-named
13 corresponding portion.

1 19. An apparatus according to claim 3, wherein said
2 control information template defines:

3 said object item in such a manner that said object
4 item detecting means detects a portion of the HDL
5 description, which portion is unable to be synthesized
6 by a logic synthesis tool, as a portion corresponding to
7 said object item; and

8 said modification rule in such a manner that said

9 object item modifying means adds to the last-named
10 corresponding portion, which has been detected by said
11 object item detecting means, a directive for instructing
12 said logic synthesis tool to ignore said last-named
13 corresponding portion.

1 20. A computer-readable recording medium in which
2 a program for automatically modifying circuit design
3 information (hereinafter called the HDL description)
4 described in a hardware description language (HDL) is
5 recorded, wherein said program instructs a computer to
6 function as the following:

7 (a) HDL lexical analysis means for performing a
8 lexical analysis of the HDL description which is to be
9 modified;

10 (b) HDL syntax analysis means for performing a syntax
11 analysis of the HDL description based on the result of
12 the lexical analysis by said HDL lexical analysis means,
13 to convert the HDL description into a parse tree format
14 description;

15 (c) semantic grammar error detection means for
16 performing a semantic analysis of the HDL description based
17 on the result of the syntax analysis by said HDL syntax
18 analysis means, detecting a portion of the HDL description,
19 in which portion variables on right and left sides of an
20 assignment statement are inconsistent in type, and
21 regarding the detected portion as a semantic-grammar-error

22 portion;

23 (d) semantic grammar error modifying means for
24 modifying said semantic-grammar-error portion into a
25 correct description by applying a type conversion function,
26 which converts the type of the variable on the right side
27 of the assignment statement into that of the variable on
28 the left side of the assignment statement, to the right
29 side of the assignment statement which side has been
30 regarded as said semantic-grammar-error portion by said
31 semantic grammar error detecting means;

32 (e) HDL reverse syntax analysis means for performing
33 a reverse syntax analysis of the HDL description, which
34 has been modified by said semantic grammar error modifying
35 means, to convert the HDL description from said parse tree
36 format description into an ordinary format description;
37 and

38 (f) comment attaching means for attaching a comment
39 about the modification to the modified portion, which is
40 the portion as the result of the modification by said
41 semantic grammar error modifying means.

1 21. A computer-readable recording medium according
2 to claim 20, wherein said program further instructs the
3 computer to function as the following:

4 (g) object item detecting means for detecting a
5 portion corresponding to a to-be-modified item
6 (hereinafter called "object item") in the HDL description,

7 which item is not a grammar error but should be considered
8 in view of circuit designing, based on the result of the
9 syntax analysis by said HDL syntax analysis means; and

10 (h) object item modifying means for modifying the
11 last-named corresponding portion, which has been detected
12 by said object item detecting means, in accordance with
13 a modification rule which has been defined previously for
14 said object item;

15 said HDL reverse syntax analysis means being operable
16 to perform a reverse syntax analysis of the modified HDL
17 description, which is the description as the result of
18 the modification by said semantic grammar error modifying
19 means and said object item modifying means;

20 said comment attaching means being operable to attach
21 a comment about the modification to the modified
22 corresponding portion, which is the portion as the result
23 of the modification by said semantic grammar error
24 modifying means and said object item modifying means.

1 22. A computer-readable recording medium in which
2 a program for automatically modifying circuit design
3 information (hereinafter called the HDL description)
4 described in a hardware description language (HDL) is
5 recorded, wherein said program instructs a computer to
6 function as the following:

7 (a) HDL lexical analysis means for performing a
8 lexical analysis of the HDL description which is to be

9 modified;

10 (b) HDL syntax analysis means for performing a syntax
11 analysis of the HDL description based on the result of
12 the lexical analysis by said HDL lexical analysis means,
13 to convert the HDL description into a parse tree format
14 description;

15 (c) object item detecting means for detecting a
16 portion corresponding to a to-be-modified item
17 (hereinafter called "object item") in the HDL description,
18 which item is not a grammar error but should be considered
19 in view of circuit designing, based on the result of the
20 syntax analysis by said HDL syntax analysis means;

21 (d) object item modifying means for modifying the
22 last-named corresponding portion, which has been detected
23 by said object item detecting means, in accordance with
24 a modification rule which has been defined previously for
25 said object item;

26 (e) HDL reverse syntax analysis means for performing
27 a syntax analysis of the modified HDL description, which
28 is the description as the result of the modification by
29 said object item modifying means, to convert the HDL
30 description from said parse tree format description into
31 an ordinary format description; and

32 (f) comment attaching means for attaching a comment
33 about the modification to the modified corresponding
34 portion, which is the portion as the result of the
35 modification by said object item modifying means.